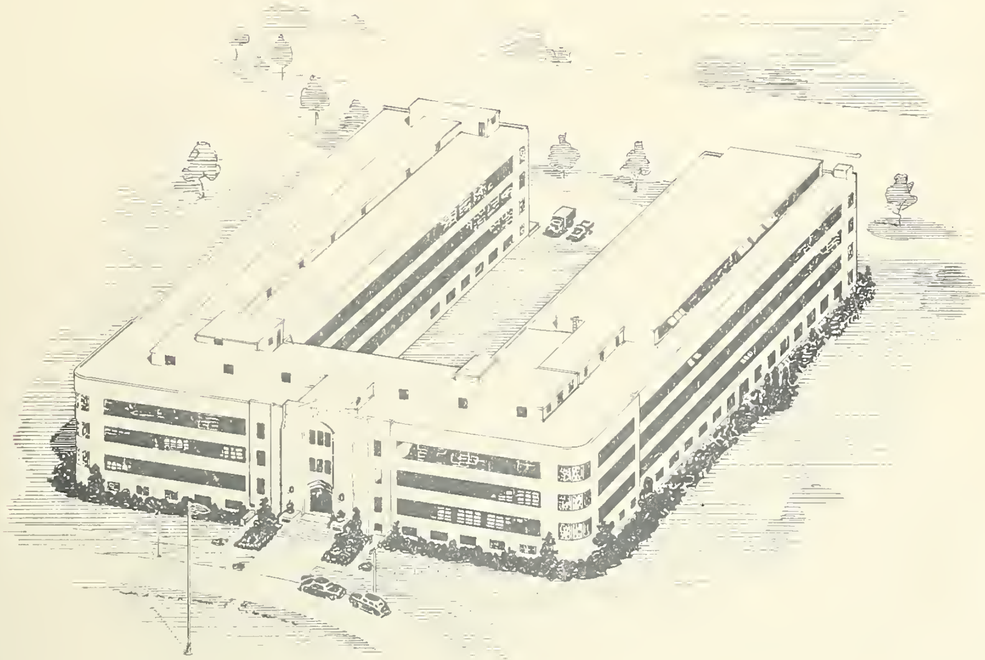
UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Agricultural and Industrial Chemistry

HIGH-DENSITY, FULL-FLAVOR APPLE JUICE CONCENTRATE

Roderick K. Eskew, C. S. Redfield, and G. W. Macpherson Phillips



Eastern Regional Research Laboratory
Philadelphia 18, Pennsylvania.

AUGUST 1951

AIC-315

HIGH-DENSITY, FULL-FLAVOR APPLE JUICE CONCENTRATE

Roderick K. Eskew, C. S. Redfield, and G. W. Macpherson Phillips

Eastern Regional Research Laboratory
Philadelphia 18, Pennsylvania

CONTENTS

INTRODUCTION

The use of concentrated fruit juices capable of being conveniently made into beverages by the addition of cold water has increased enormously in recent years. This is especially true of frozen concentrated orange juice. This laboratory has published some work on both frozen concentrated grape juice and apple juice[1,2]. The Western Regional Research Laboratory has reported the preparation of 4-fold frozen concentrates from the depectinized, clarified juice of apples grown in the Pacific Northwest[3]. The preparation of a high-density (7-fold), full-flavor apple juice concentrate which would retain its flavor when stored under ordinary refrigeration has long been the goal of fruit juice processors. The possibility of making such a product, as a consequence of the development of a method for recovering volatile flavors in essence form, was referred to in earlier publications of the Eastern Regional Research Laboratory[4,5], but no recommended procedures for its manufacture or data on its storage properties have heretofore been presented. This publication gives a method for manufacturing a full-flavor 7-fold concentrate which can be stored satisfactorily at 35° F. for a year, and which when reconstituted with cold water will give a beverage comparable to high-grade single-strength bottled apple juices now on the market. There are significant economies in producing a 7-fold concentrate which can be stored at 35° instead of a 4-fold frozen concentrate requiring low temperature storage. However, the two products yield slightly different juices when reconstituted. The juice from a 7-fold concentrate resembles a high-grade, clarified, single-strength processed juice, whereas the 4-fold frozen product yields a beverage closer to a freshly pressed juice. The choice is one of personal preference.

1. Preparation of Full-Flavor Frozen Grape Juice Concentrates. By R. K. Eskew, G. W. M. Phillips, R. P. Homiller, and N. H. Eisenhardt. U. S. Dept. Agr. Bur. Agr. and Indus. Chem. AIC-301 (Eastern Regional Research Laboratory) March 1951. (Processed).

2. Frozen Concentrated Apple Juice. By R. K. Eskew, G. W. M. Phillips, R. P. Homiller, Clifford S. Redfield and R. A. Davis. (Pending publication in Industrial and Engineering Chemistry).

3. Frozen Apple Juice Concentrate: Application of Laboratory Data to Prospective Commercial Operations. By Vern F. Kaufman, C. C. Nimmo and L. H. Walker, U. S. Dept. Agr. Bur. Agr. and Indus. Chem. AIC-293 (Western Regional Research Laboratory), November 1950. (Processed).

4. Recovery and Utilization of Natural Apple Flavors. by H. P. Milleville and Roderick K. Eskew. U. S. Dept. Agr. Bur. Agr. and Indus. Chem., AIC-63 (Eastern Regional Research Laboratory), September 1944. (Processed).

5. Recovery of Volatile Apple Flavors in Essence Form. by H. P. Milleville and R. K. Eskew. Western Canner and Packer, 38: 51-54. October 1946.

GENERAL PROCESS

Figure 1 shows a flow sheet of the process. Briefly, the process consists in extracting the juice in the conventional way from sound apples, straining it through a 200-mesh screen and them pumping it to an essence-recovery apparatus to obtain the aroma in concentrated or "essence" form. The stripped juice is depectinized so that it may be concentrated to high density without gelling. It is then filtered, the enzyme is inactivated, and the juice is concentrated under vacuum to approximately 71° Brix. The essence is added to the concentrate, and the mixture is cooled, packed in 6-ounce cans, and stored at 35° F. When reconstituted with 6 volumes of cold water per volume of concentrate, the product will have the aroma of freshly pressed apple juice.

DETAILS OF OPERATIONS

A satisfactory product can be made only from the properly blended juice of sound mature apples processed so as not to injure the flavor. For this reason, sound practices in juice preparation are described here. Unlike the recommendations made for preparing the concentrated product, these are not based on research conducted at this Laboratory.

Apples: It is important that good housekeeping and sanitation be employed and that sound apples be used. It is poor economy to compromise with quality of the fruit. If juice-grade apples are used, they must be carefully sorted to remove rots. Sorting conveyors should be of the roller type to expose all surfaces to view. Hand trimming of bruised areas jeopardizes quality and is of questionable economy. If done, an area of sound fruit would have to be included in the cutout and all bits of decayed material washed off.

Maturity is an important factor in flavor, since unripe fruit may contribute excessive tartness or astringency, and apples held too long in storage may yield an insipid earthy juice of dark color.

Apple varieties must be considered in achieving proper balance between tartness, astringency, and aroma of the product. It is impractical to recommend an ideal blend, for each variety changes with season and locality. Furthermore, the processor must use the varieties available. In general, the blend should include enough acid varieties, typified by Northern Spy, Jonathan, and Baldwin, to give the product an acidity of between 0.40 and 0.50 percent as malic acid for a juice of 12.5° Brix; that is, the ratio of Brix to acid should preferably be between 31 and 25. There must also be in the blend enough of the more aromatic varieties, such as McIntosh, Winesap, Jonathan, and Golden Delicious, to contribute bouquet. During the fall of 1950, an experimental pack of good quality concentrated apple juice was made at this Laboratory from a blend in equal proportions of juice from Eastern grown McIntosh, Jonathan, Red Delicious, Stayman Winesap, and Baldwin apples.

HIGH-DENSITY FULL-FLAVOR APPLE JUICE CONCENTRATE

417 GALLONS PER HOUR OF JUICE

1275 6-OZ. CANS PER HOUR OF 68.5° BRIX FULL-FLAVOR CONCENTRATE

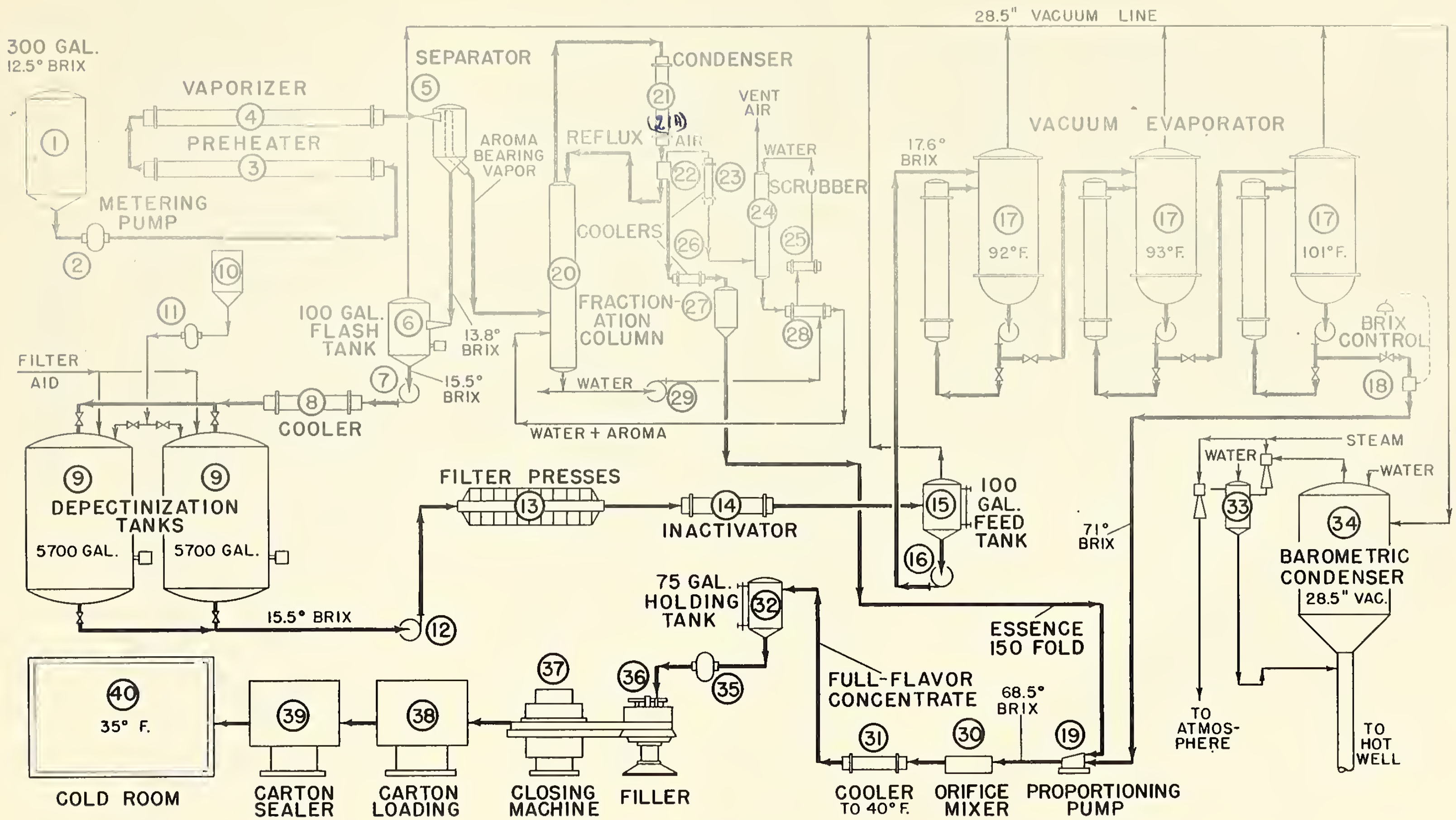


FIGURE I

The fruit should be thoroughly washed to remove dirt and spray residues Experience shows that a first wash containing 0.5 percent of hydrochloric acid and a detergent such as Emulphor ELA [6], followed by a water rinse, is satisfactory.

Juice Preparation: The sorted washed apples are ground in a hammer mill having a screen with holes 1/2-inch in diameter. They are then pressed in a rack and frame press in the usual way. A yield of 160 gallons of juice is generally obtained from a ton of apples.

Dry press cloths should be soaked overnight before use. Cloths should be washed at least every 4 hours to remove adhering pomace, then steamed to destroy microorganisms, and finally rinsed. Nylon cloths are finding increasing use. Racks and frames and all parts of the press coming in contact with the juice should be washed, on the same schedule as the cloths, with high-pressure hot water jets. The racks should be steamed, and after partial drying to prevent scouring, they should be stacked in a way to permit circulation of air.

The juice from the press should be screened through a reel covered with a 200 mesh stainless steel screen to remove fragments of tissue. It is then pumped to a holding tank, from which it is fed at a fixed rate to the essence recovery unit. There should be a minimum of delay between pressing, and essence stripping. Permitting the juice to stand may result in loss of aroma, or in enough fermentation to increase the alcohol content of the essence above the legal limit.[7].

Essence Recovery. The purpose of recovering the aroma in essence form is to restore to the concentrate the fragrance of the fresh apples without significant dilution. This fragrance would otherwise be lost during vacuum concentration of the juice.

The basic design for an essence recovery unit with a capacity of 1000 gallons of juice an hour was published by Milleville and Eskew[5]. More recently, improvements in essence recovery, especially as regards time of heating the juice and vent-gas scrubbing, have been developed. A pilot plant unit embodying these improvements has been described[8]. Table III contains the basic engineering data for the design of an essence-recovery unit having a capacity of 417 gallons of juice per hour when 10 percent is vaporized which is customarily done with apple juice. Improvements over earlier designs include separation of the evaporator into preheating and vaporizing sections, thereby minimizing surging and greatly reducing the heat effect of the juice.

6. Recommendation of this specific product is not implied. Products of other manufacturers may be equally effective.

7. See Code of Federal Regulations, Title 26, Pt. 198, 1950. Volatile Fruit-Flavor Concentrates.

8. Experimental Unit for Recovery of Volatile Flavors, by G. W. Macpherson Phillips, Roderick K. Eskew, Joseph B. Claffey, Rudolph A. Davis and Richard P. Homiller, Presented at the Meeting-In Miniature, Phila. Section, American Chemical Society, January 18 1951. Ind and Eng. Chem. *43*, 1672-1675, July 1951.

This is done by making the diameter of the preheater tube small enough to give a high juice velocity, preferably 9 to 15 feet per second, and by designing all pipes and parts carrying hot juice so that their volume is reduced to a minimum. Furthermore, the preheater tube is small enough to attain turbulent flow by the "Reynolds number" criterion, in the preheater. Besides insuring uniform heating of all parts of the stream of juice passing through the preheater, this reduces fouling of the tubes. This system of essence stripping pasteurizes the juice and inactivates the enzymes and does not damage the flavor of the juice. Vent gases are scrubbed from the condenser with chilled column bottoms instead of with chilled essence as formerly. A. H. Brown et al.[9] have used a device which preheats the juice by direct injection of steam instead of by passing it through a steam-heated tube, to reduce heating time and to eliminate fouling of tubes. This device requires a special supply of odorless steam and necessitates evaporating from the juice the water resulting from condensation of the injected steam which will amount to about 13 percent of the weight of the juice

Depectinization and Clarification: To concentrate the stripped juice to high solids without gelling, it is necessary to remove the pectin. This is conveniently done by adding a commercial pectinase such as Pectinol A[6]. The time required for destruction of the pectin is a function of temperature and concentration of pectinase. The following data taken from information supplied by the manufacturers of Pectinol A illustrate the wide range of conditions under which the enzyme will destroy pectin.

Ounces of Pectinol A per 100 gallons of cider under different conditions of time and temperature

Temperature Degrees F	5 hours	15 hours	30 hours	48 hours
40	-	30	15	10
60	54	18	9	6
100	14	5	-	-

To avoid damage to the flavor of the stripped juice to be depectinized, it is recommended that the temperature not exceed 70° F. A temperature of 65° F. is used in the example of how this step could conveniently be carried out in the plant for which equipment requirements and cost data are given. The enzyme, dissolved in a small quantity of juice, is added continuously to a tank (Figure 1), (9) into which the day's production of stripped juice is discharged. The amount of Pectinol A to be added in the example cited would be approximately 1 pound per 100 gallons of juice. Depectinization would proceed during the day as the juice accumulates and would continue during the night. It should be possible to keep the juice without spoilage for this

9. Flash Heat, by A. H. Brown, M. E. Lazar, T. Wasserman, and W. D. Ramage. Food Packer 32, (1) 20-21, 38, 40, 42, 44 January 1951. Pt. 2, Flash Heating Concentrating. Food Packer 32 (2) 34-35, 73-74, February 1951. Rapid Heat Processing of Fluid Foods by Steam Injection. By A. H. Brown, M. E. Lazar, T. Wasserman, G. S. Smith, M. W. Cole. Presented at the 119th National Meeting of the American Chemical Society, Boston, Mass April 1-5, 1951. (To be published in Ind. Eng. Chem.)

length of time if precautions are taken to keep the depectinization tanks in a sanitary condition, for the stripped juice as it leaves the essence-recovery equipment is effectively pasteurized; biological tests show complete destruction of yeasts and all bacteria capable of surviving in the juice.

Carbon filters should be provided on the breather pipes on the depectinization tanks to prevent ingress of microorganisms.

The heat treatment given the j
some of the proteinaceous mater
insolubles. Hence filtration
plate and frame filter press ma
co~~ated with~~ filter aid, ~~but adc~~
such as Dicalite Speedflow[6] ~~to each 100 gal~~
or equivalent may be used."

To ensure that no cloud develops in the filtered juice, it is desirable to inactivate the enzyme after depectinization. This should be done under the mildest possible conditions to avoid damage to the flavor of the juice. Experience has shown that very rapid heating and cooling is desirable. For example in the inactivator (14) the juice is heated to 210°F in less than half a second. The desired holding time of 2 seconds at 210° F can be had by passage through a 3-foot section of 1-inch pipe between the inactivator and the vacuum feed tank (15). The inactivated juice is quickly cooled when it flashes into the tanks.

Juice Concentration: Assuming that the essence to be used in the concentrate is 150-fold, the stripped juice must be concentrated to 71° Brix so that on addition of the essence the product can be diluted with 6 volumes of water to yield a beverage of 12.5° Brix. Experience has shown that although a 26-inch vacuum is satisfactory for making a 4-fold apple juice concentrate, it is desirable to use a higher vacuum to minimize the slight baked-apple flavor that frequently characterizes 7-fold concentrates. It is not yet known whether or not the high vacua used in concentrating orange juice would completely eliminate this. It is doubtful that its elimination would justify such an elaborate installation, since our experience has shown that a vacuum of 28.5 inches will give a satisfactory product, which even after a year's storage at 35° F. can be reconstituted to a beverage which compares favorably with high-grade single-strength processed juice. A typical evaporator (17) for concentrating the juice under 28.5 inches of mercury is described in Table III. An evaporator operating at a 26-inch vacuum such as suggested for 4-fold concentrate[2] might be used here but at the risk of contributing a cooked flavor to the product. Where this is unobjectionable, the resulting saving of approximately 1/2 cent per 6-ounce can would be significant.

Incorporation of Essence: A proportioning pump (19) followed by an orifice mixer (30) continuously mixes 4.9 gallons of 150-fold essence with each 100 gallons of 71° Brix concentrate to yield a concentrate of 68.5° Brix containing the aroma of the freshly pressed juice. A single motor operates the proportioning pump with automatic cutoff in event of failure of one of the streams coming to the pump.

To ensure having a concentrate stream of constant density coming to the proportioning pump, an automatic density control (18) is located in the concentrate line. It actuates a valve on the discharge line from the evaporator.

Filling and Packaging: The full-flavor concentrate is chilled to 40°F. in a cooler (31) and held in a small tank (32), from which it is pumped to a piston-type filler (36). This type of filler is required because the viscosity of the product at this temperature is approximately 950 centipoises. Lacquered 6-ounce cans are used. After filling, the cans are closed, packed 24 to the carton, and stored at 35° F. The cold room has capacity for 48 hours' production.

COSTS

In estimating the cost of manufacturing high-density, full-flavorconcentrated apple juice, it is assumed that the operations will be carried out by a company already in the business of producing single-strength juice. The estimates, therefore, cover only the cost subsequent to juice manufacture. It is further assumed that a suitably fenced plot, roads, parking areas, railroad sidings, truck facilities, office furniture, and fixtures are already available. Allowance is made, however, for the additional buildings, including the boilerhouse, and for preparation of the building site.

Since it is unlikely that a small producer of apple juice would be in a position to make the large investment for conversion to the concentrated product, the cost estimates are based on a plant producing 417 gallons of juice per hour, equivalent to pressing approximately 2.7 tons of apples per hour. The factory would turn out 20,400 six-ounce cans of the product per day. This assumes that the starting juice is 12.5° Brix and is available at a rate of 417 gallons per hour. The finished product will be 68.5° Brix and will yield a juice of 12.5° Brix when diluted with 6 volumes of water. It is assumed that the factory would operate 75 days per year, 5 days per week, and 16 hours per day, that is, 2 eight-hour shifts plus additional time for cleaning operations.

Table I shows a capital cost sheet. It will be seen that the total fixed capital required is $220,000; an additional $33,000 is required for working capital.

Table II, a cost sheet, shows that a high-density, full-flavor concentrated apple juice can be produced for approximately 8 cents per 6-ounce can. This is the "cost to make" and includes not only the actual production costs

but all other items such as administration, general expense, interest on investment and working capital. As previously pointed out, however, it does not include the cost of the juice.

The costs of packaging and transportation of high-density concentrate in 6-ounce cans are both far less than those of an equivalent amount of single-strength juice in the customary quart bottles. Quart bottles and their cartons cost 7.70 cents per bottle; since a 6-ounce can makes 42 ounces of juice, this is equivalent to 10.11 cents per 6-ounce can of concentrate. Six-ounce cans and their cartons cost about 2.34 cents per can, a saving of 7 77 cents per can. A quart bottle of juice weighs about 3.30 pounds. Each 42 ounces of juice (the amount made from a 6-ounce can of concentrate) if shipped as bottled juice would therefore weigh 4.33 pounds. A 6-ounce can of concentrate weighs only 0.57 pound. Freight rates of course vary greatly, but may usually be taken as 1.5 times as much for refrigerated cans as for single-strength processed juice. On this basis, the freight cost will average only 20 percent as much for concentrate as for an equivalent amount of bottled juice. On a typical 200-250 mile haul, this is a saving of 2.02 cents per can, which, added to the 7.77 cents saving in cost of containers, totals 9.8 cents per can. Since in our typical 417 gallons per hour plant, the total "cost-to-make," including all costs and fixed charges except the cost of the raw juice, is only 8.0 cents per can, the saving of 9.8 cents per can would more than pay for the entire "cost-to-make," and provide 1.8 cents per can which could apply against the cost of making the juice. Actually the financial picture is even more favorable than this, because in this calculation no credit has been taken for omitting the costs of the pasteurizing and bottling operations, which are a part of the production of conventional bottled juice. This credit has been omitted to cover the immediate amortization of the bottled juice processing equipment by any processor who already has it.

The annual saving in cost of containers that would result from making high-density concentrate instead of single-strength bottled juice is depicted in Figure 2. It amounts to approximately $119,000 per year. The great reduction in space that would be occupied in warehouses is graphically shown.

Table III gives a brief description of the major pieces of equipment required and the estimated cost of each. The numbers correspond to those shown on the flow sheet in Figure 1. These particular pieces of equipment and their sizes are chosen merely to illustrate one way of carrying out the process and to establish a basis for a cost estimate. For many of the steps, other apparatus of equivalent function can be substituted for that listed. Moreover, the choice of apparatus was made on a liberal basis rather than with an attempt to determine the absolute minimum cost. For example, the costs allowed for depectinization tanks and other tanks in which juice or

COMPARATIVE PACKAGING COST OF HIGH-DENSITY CONCENTRATE AND SINGLE-STRENGTH JUICE

(417 GALLONS OF JUICE PER HOUR)

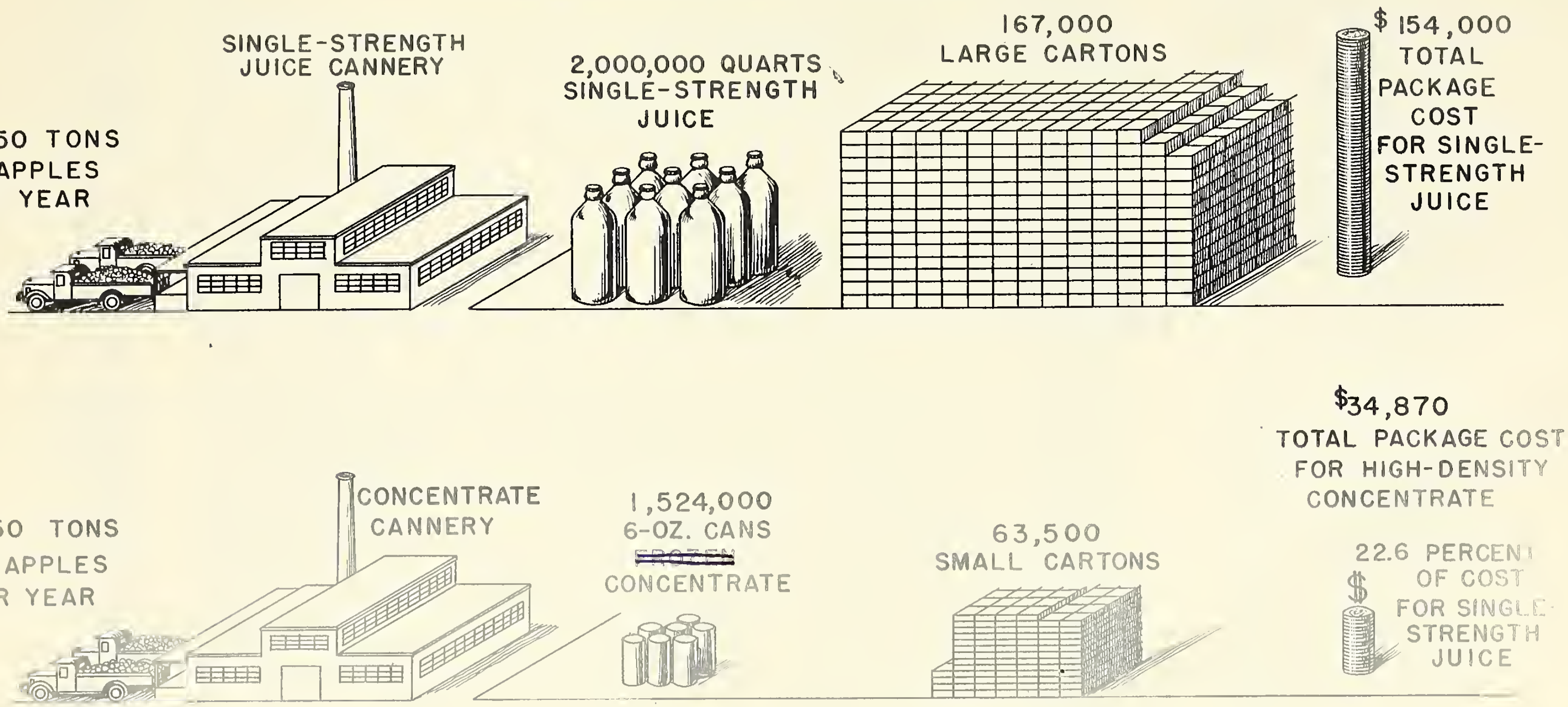


FIGURE 2

concentrate is handled are sufficient to permit the use of a Number 4 finish on the interior to facilitate sanitation. Likewise, all pumps, piping and fittings for juice and concentrate are of stainless steel and of sanitary type.

USES

Because of its small space requirement and the fact that it may be kept under ordinary refrigeration, high-density concentrated apple juice can be of value in supplying the Armed Services.

In considering its possibilities in the retail market in competition with a frozen concentrated apple juice, the following factors should be borne in mind: The consumer can obtain reconstituted juice at less cost from high-density concentrate than from frozen concentrate. This fact might have to be advertised to induce the consumer to pay more for a 6-ounce can of high-density unfrozen product than for a 6-ounce can of frozen juice. The public is conditioned to the merits of frozen juices and is accustomed to dilute them easily with 3 volumes of water to obtain a beverage cold enough to be palatable. A high-density apple juice concentrate is less easily reconstituted; more stirring is required to disperse it in the water because of its high viscosity. Moreover, it would not be so cold unless colder water were used, for 6 volumes of water are required instead of the 3 used with the frozen product. But with rising food prices, the economy of the more concentrated product will become of increasing importance.

Other uses for the product suggest themselves. A table sirup of new and pleasing flavor can be made by blending the full-flavor concentrate in equal proportions with corn sirup and invert sirup. This reduces the acidity of the concentrate and the cost of sirup.

The concentrate can be used for making sherbets, ices, carbonated beverages and most food products in which all the components of apple taste and aroma are desired.

SUMMARY

The advantages of concentrated fruit juices are evidenced by the rapid increase in consumption of frozen concentrated orange juice and grape juice. The frozen juices are generally 4-fold, that is, they require 3 volumes of water to one volume of concentrate. This paper describes a 7-fold, high-density, concentrated apple juice which does not require frozen storage. It will keep satisfactorily for a year or more at 35° F.

The method for retaining the aroma of the fresh juice in the concentrate entails essence recovery by the process developed at the Eastern Regional Research Laboratory, now used commercially for making full-flavor concentrated juices. Because of the high degree of concentration, the juice must be depectinized.

Cost estimates show that an apple-processing plant producing 417 gallons of juice per hour can be converted to a concentrate plant by a total capital investment of $220,000. In such a plant, freshly pressed apple juice can be processed into high-density, full-flavor concentrate at a total cost of about 8 cents per 6-ounce can, including costs of containers and all overhead costs but not the cost of the fresh juice. The saving in cost of containers alone over those required for bottled juice amounts to 7.77 cents per 6-ounce can of concentrate.

TABLE I

CAPITAL COSTS OF MAKING HIGH-DENSITY FULL-FLAVOR, APPLE JUICE CONCENTRATE

Preparation of site	$ 2,000
Buildings	20,000
Boilers	12,000
Equipment for manufacturing	59,000
Erection of equipment	15,000
Instrumentation	2,500
Piping and ductwork	27,000
Erection of piping and ductwork	20,000
Heating, installed	2,000
Lighting, installed	2,000
Power, installed	2,000
Freight on equipment	1,500
Contingencies	22,000
Engineering fees	33,000
Total fixed capital	220,000
Working capital	33,000
Total capital	$253,000

TABLE II

COST SHEET

Cost Per Day to Make High-Density, Full-Flavor Apple Juice Concentrate Based on a 16-Hour Day and 1200 Operating Hours Per Year

	Cost per day
Prime Cost	
Material	
52.9 lbs. filter aid	$ 1.32
52.86 lbs. Pectinol A at $0.50/lb.	26.43
Total	27.75
Labor	233.60
Total	261.35
Indirect Materials	
Filter Cloth	0.14
Cans	408.00
Cartons	56.95
$CaCl_2$	0.07
Total	465.16
Factory Overhead	
Indirect labor	
Supervision	48.00
Watchmen, yard men	41.07
Mechanics, etc.	16.00
Office help	8.00
Indirect expense	
Insurance personal liability and fire	14.64
Taxes	58.57
Interest, fixed capital	46.43
Social security	5.33
Workmen's compensation	3.91
Unemployment insurance	10.40
Depreciation	292.87
Maintenance, repairs and renewals	135.23
Power	13.17
Steam	38.83
Water	12.16
Gasoline	3.65
Factory supplies	3.96
Total Factory Overhead	852.22
Total Factory Cost	1,578.73
Interest on working capital	6.02
Administrative and general expense	51.59
Total Cost to Make	1,636.34

Production rate, 20,400 6-oz. cans per day

Cost to make per 6-oz. can $\frac{\$1,636.34}{20,400} = \$0.0802$

TABLE III

EQUIPMENT SUMMARY

Item No.	Equipment	Estimated Cost
1	Holding tank: Stainless steel, closed tank; standard dished heads, removable top head; bottom discharge; 300 gals. capacity.	$ 1,100
2	Pump: Stainless steel, positive delivery, sanitary type; 7 gpm at 50 psi.	300
3	Preheater: Stainless steel throughout except carbon steel shell; 2 pass; 6 tubes per pass; 14 sq. ft.; tubes 3/8" O.D., 18 ga., 12 ft. long.	1,500
4	Vaporizer: Stainless steel throughout except carbon steel shell; single pass; 8 tubes, 1" O.D., 18 ga., 12 ft. long; 25 sq. ft.	1,900
5	Liquid-vapor separator: Stainless steel, 8" dia. separator body; 4" dia. vapor outlet; 3" vapor inlet; 18" long.	400
6	Flash cooling tank: Stainless steel, closed tank; standard dished heads; 100 gal., capacity; ~~side agitator~~; hand holes ~~and feeder for filter aid~~; operates under a vacuum of 28.5" Hg.	1,400
7	Pump: Centrifugal, stainless steel, sanitary type; 5.5 gpm at 60 ft. head.	300
8	Heat exchanger: Stainless steel throughout; fixed tube sheets; removable heads; cools 5.5 gpm 15.5° Brix from 90° to 65° F.; 50 sq. ft.	800
9	Depectinizing tanks: Two required. Stainless clad steel; standard dished heads, top head provided with manhole and breather pipe with activated carbon; side agitator; each tank holds 5700 gals. for 16 hours' operation.	15,000
10	Tank: For pectinol solution; stainless steel, 50 gals. capacity.	300
11	Pump: Metering; 37 gals. in 8 hours.	300
12	Pump: Centrifugal, stainless steel, sanitary type; 5.5 gpm at 35 ft. head.	200

TABLE III (Con't)

EQUIPMENT SUMMARY (Con't)

Item No. ... ed

Page 15, Item 1

"Filter Press:

...ress 12" x 12"

...frames.

14	Heat exchanger (inactivator); Stainless steel throughout except carbon steel shell; tubes 3/8" O. D. x 18 ga., 12 ft. long; 2 pass, 5 tubes per pass; 12 sq. ft.; heats 2900 lbs. per hr. from 65° to 210° F.; total equivalent holding time of 2 sec. at 210° F. required for inactivation, obtained by use of 30 cu. in. holding chamber; for example: 36" of 1" pipe between items 14 and 15.	1,300
15	Holding tank: Stainless steel, closed tank; standard dished heads; 100 gals. capacity; operates under an absolute pressure of 1.5" Hg.	500
16	Pump: Centrifugal, stainless steel, sanitary type; 5 gpm.	200
17	Evaporator: Outside-calandria type with separator body and forced feed; all parts in contact with the product made of stainless steel; three units all operated at a pressure of 1.5" Hg. absolute; the juice flowing continuously through the three units in series; 10 psi. ga. steam supplied to calandrias; concentrates 2600 lbs. per hr. from 17.6% solids to 71% solids with an evaporation of 1950 lbs. per hr.; total heating surface 50 sq. ft. or 16.7 sq. ft. per unit. Price includes piping, condenser, with tail pipe and jets with intercondenser for noncondensables, calandrias, separator bodies, pumps, motors and supports and hogging jet for starting.	8,500
18	Brix control: An automatic device for maintaining the discharged product from the evaporator at 71° Brix for control of blending operations.	1,400
19	Pump: Proportioning, stainless steel; mixes 4.93 gals. of 150-fold essence with 100 gals. of 71° Brix concentrate to give product of 68.5° Brix.	1,500

TABLE III (Con't)

EQUIPMENT SUMMARY (Con't)

Item No.	Equipment	Estimated Cost
20	Column: Packed, stainless steel shell; packing supports, reboiler, and accessories; 9" dia. shell packed with 1" Raschig rings; 6 ft. enriching section; 2 ft. stripping section and 1 ft. spacing; operates at 69% of flooding.	$ 1,000
21	Condenser: Stainless steel throughout ...	200
	"Item 21a cooler: Stainless steel throughout; fixed tube sheets and removable heads; cools 0.7 gpm from 210° F. to 100° F.; 7 sq. ft.; 9 tubes 4 ft. long; 3/4 inches O.D., 18 ga. $200."	
22	Liq... in item 23).	
23	Heat exchanger: Gas cooler; volume of noncondensable gas assumed to be 10% of feed; stainless steel; ...; fixed tube sheets; removable heads, 4.0 sq. ft. throughout. (Price includes items 22, 24, 25 and 26).	400
24	Scrubber: Volume of noncondensables assumed to be 10% of feed; stainless steel scrubber 2" dia. by 5 ft. long packed with 1/4" saddles. (Price included in item 23).	
25	Liquid cooler: Brine; stainless steel throughout; fixed tube sheets, removable heads; 0.5 sq. ft. (Price included in item 23).	
26	Cooler: Stainless steel throughout, fixed tube sheets, and removable heads, 0.5 sq. ft. (Price included in item 23).	
27	Essence receiver: Stainless steel, closed vessel; 50 gals. capacity.	200
28	Heat exchanger: Stainless steel throughout, fixed tube sheets; removable heads. 1.0 sq. ft.	100
29	Pump: Centrifugal, stainless steel, sanitary type; 3 gph.	100
30	Mixer: Orifice; stainless steel; series of six offset orifices in pipe serves as mixer.	100
31	Cooler: Brine; stainless steel throughout; fixed tube sheets; removable heads; product inside tubes; brine outside; 7 sq. ft.; insulated with 4" cork.	250

TABLE III (Cont'd)

EQUIPMENT SUMMARY (Con't)

Item No.	Equipment	Estimated Cost
32	Holding tank Stainless steel closed tank with breather, standard dished heads; top head removable; 75 gals. capacity; insulated with 3" cork.	$ 450
33	Jets Steam. Two jets with intercondenser for removing noncondensable gases from barometric condenser (Price included in item 17).	
34	Condenser Barometric; should be of sufficient size to handle vapors from the evaporator (17), and flash tanks (6) and (15), i.e., 2650 lbs. per hr and the necessary condensing water; provided with jets (33) for removing noncondensables, tail pipe 34 ft. long, discharging into a hot well, and hogging jet for starting up system. (Price included in item 17).	
35	Pump: Positive delivery, stainless steel, sanitary type; handles 666 lbs. per hr., 68.5° Brix concentrate at 50 psi.	250
36	Filling machine: 68.5° Brix at 40° F.; viscosity 950 cps., piston-type filling machine; handles 1275 six-oz. cans per hour.	4,000
37	Closing Machine: Standard; closes 1275 six-oz. cans per hr.	1,800
38	Carton loading: Conveyor belt. Loads 6-oz. cans into cartons.	550
39	Carton sealer: Seals filled cartons.	200
40	Cold storage room. Operates at 35° F.; must hold 2 days' production or 40,800 six-oz. cans.; room 12 ft x 32 ft., insulated with 4" of cork; requires 3 tons refrigeration.	4,700
	Brine system: Brine tank; 3 ft. x 2-1/2 ft. x 5 ft.; insulated with 4" cork; two centrifugal pumps.	700
	Refrigeration. Additional for brine system; 3.6 tons	2,300
	Pallets. Forty required; 34 x 41".	200
	Trucks: Three required; hand lift.	1,100
	Total	$59,000